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Short Communication

Note on the Influence of Leaf Extracts of Nine Trees on Seed Germination, Radicle and Hypocotyl Elongation of Maize and Sorghum

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ABSTARCT

Allelopathic effect of water extract from fresh leaves of nine agroforestry tree types on germination, seedlings survival, hypocotyl and radicle length and days to first emergence of maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L.) was investigated in a growth chamber. Extracts from *Spina christi*, *Sesbania sesban and Tamarindus indica* caused significant reduction in germination of seeds of both crops by 14% to 71%. Across all extracts, germination of seeds and seedlings survival of sorghum were significantly less affected than those of maize. Higher (compared to the control) survival of maize and sorghum seedlings were obtained in extracts from *Khaya senegalensis, Peltophorum plerocarpum, Prosopis africana, Eucalyptus camaldulensis* and *S. christi*. For both crops, extract from *Acacia nilotica* imposed less effect on hypocotyl length. The same extract significantly increased radicle length of maize and sorghum seedlings by 47% and 55%, respectively. Extracts forced maize seeds to germinate earlier, while the opposite was observed for sorghum seeds.

Key Words: Allelopahy; Extracts; Germination; Hypocotyl; Maize; Radicle; Sorghum

INTRODUCTION

In the Sudan, beneficial effects of tree litter on the crop-soil system were previously reported (Hussein & Abbaro, 1997; Ahmed & Nimer, 2003). This shows that with the recent forestry development plans, which put great emphasis on the establishment of plantations of indigenous and exotic species inside forest reserves and community areas (FNC, 1997), long-term soil fertility, could be sustained. It is generally known that conservation tillage maintains surface residues that reduce soil and water loss. However, organic residues have been reported to produce allelopathic compounds known as phytotoxins (organic acids, straight chain alcohols & ketones), during decomposition that may inhibit or retard germination, growth and development of some crops (Wicks *et al*., 1994; Chung & Miller, 1995; Cheema *et al.,* 2000; Farooq *et al*., 2008; Jabran *et al.,* 2009). Trees and shrubs, with their fallen litter, seem to provide a good microclimate for crops. Studies on the allelopathic influence of trees on cropped lands of the semi-arid tropics on crops are rare. El Atta and Bashir (1999) reported the adverse effects of oil extracted from *Eucalyptus camaldulensis* on germination of wheat. There is a need to screen the inhibitory influence of a wide range of water extracts, from some promising indigenous and exotic agroforestry trees in Sudan, on germination and seedling growth. Therefore, the objective of this study was to determine the effect of water extracts from some common agroforestry trees on germination and radicle and hypocotyl elongation of sorghum (*Sorghum bicolor* L.) and maize (*Zea mays* L.) crops.

MATERIALS AND METHODS

Extracts from fresh leaves of nine agroforestry tree species [(*Tamarindus indica* (Ardeib), *Khaya senegalensis* (Mahogany), *Eucalyptus camadulensis* (L.), *Prosopis africana* (Abusurj), *Albizia lebek* (Dign Elbasha), *Acacia nilotica* (Sunut), *Sesbania sesban* (Seisaban), *Spina christi* (Sidr) and *Peltophorum plerocarpum* (Peltophorum)] were used to test the effect of plant extracts on germination of seeds and survival of seedlings of sorghum (*Sorghum bicolor* L.) and maize (*Zea mays* L.). Aqueous extracts at the ratio of 1:15 (W/V) were prepared by mixing 10 g of each material with 150 mL of distilled water in a household blender for 10 min and the solutions were filtered through filter paper (Whatman No. 42). Phytotoxicity was bioassayed following the procedure of Guenzi *et al*. (1967). Seeds from sorghum and maize were sterilized for 5 min in a 1:10 solution of 5% sodium hypochloride and washed several times in distilled water. In each sterilized petri dish (8 cm diameter), 8 seeds (3 replicates) of sorghum and similar to that of maize were placed at the bottom of the dish and covered with a filter paper (Whatman No. 2). Alliquots

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(10 mL) from each extract were added to petri dishes and distilled water was used as a control. Petri dishes were incubated in a lit room at an average temperature of about 25°C for 8 days. All 12 treatments were arranged in a completely randomized block design with three replicates. Measurements included germination, radicle and hypocotyle length, survival and days to first germination. Data were analyzed using analysis of variance procedure (SAS, 1985) and means were separated by Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Germination of maize and sorghum seeds was significantly (P≤0.001) reduced by leaf extracts (Table I). For maize seeds, extracts from Ban and Peltophorum had no effect on seed germination compared to the control (87.5%); whereas extracts from other types showed a reduction in germination of maize that ranged from 14% to 71% relative to the control. The effect was in the order of Seisaban > Sunut = Dign Elbasha = Sidr > Abusurj > Ardeib = Mahogany > Ban = Peltophorum = distilled water. On the other hand, leaf extracts from Mahogany and Dign Elbasha had no significant effects on seed germination of sorghum compared to the control. However, extracts from Sidr, Seisaban, Peltophorum, Ban and Ardeib significantly reduced germination by about 15% and 43%, respectively. The lowest germination (50%) was observed in seeds treated with extracts from Sidr. Most extracts significantly (P≤0.001) reduced survival of seedlings of both crops. Maize seedlings grown in extracts from Abusurj and Peltophorum stayed healthy for 8 days (i.e., similar to the control). Reduction of survival percentage induced by other litter extracts ranged from 24% to 50% (see Table I). The effect was in the order of Seisaban = Sunut = Mahogany = Ardeib > Ban > Dign Elbasha = Sidr. For sorghum, the survival percentage in extracts from Mahogany, Ban and Sidr (99%) was significantly higher than the control (87.5%). Extracts from Ardeib, Abusurj, Peltophorum, Sunut and Seisaban reduced survival of sorghum seedlings (compared to the control) by 62%, 23%, 18% and 9%, respectively. Most of the extracts significantly (P≤0.001) affected the length of the hypocotyl of both crop species. Hypocotyl of maize seeds treated with extracts from Dign Elbasha, Sisaban and Sidr (4.0 cm to 4.2 cm) were significantly longer than the control (3.5 cm) by about 16%. Hypocotyl from maize seeds treated with Sunut had similar length (3.3 cm) to that of the control (3.5 cm). Reduction induced by Ardeib, Mahogany, Ban and Abusurj was found to be 29% and 54%, respectively. The highest reduction was observed in extracts of Mahogany. Regarding sorghum, the effects of extracts on hypocotyl length were generally erratic. Seeds treated with extracts from Ardeib and Sunut had the highest (3.3 cm) length compared to the control (2.0 cm). Generally, some extracts increased hypocotyl length by about 15% to 69%. Most extracts had significant (P≤0.001) effect on radicle length of seedlings from maize and sorghum. Extracts of Seisaban, Sunut and Abusurj increased radicle length of maize by about 19% to 88%, while extracts from Sidr, Dign Elbasha, Mahogany and Ardeib reduced radicle length by 53% to 78%. Maximum length (6.0 cm) was obtained in seeds treated with extracts from Seisaban, while the lowest (0.7 cm) was observed in extracts from Peltophorum. However, addition of extracts from Ban, Mahogany, Seisaban and Sunut significantly increased radicle length of sorghum seedlings by about 55% to over 200%. Extracts from Peltophorum, Sidr and Ardeib decreased radicle length by 80%. The number of days to first emergence was significantly (P≤0.001) influenced by leaf extracts. The two crops responded differently to the treatments. For example, days to first emergence of treated maize seeds (2 days) was 50% earlier for all treatments compared to the control (3), while most extracts (Ardeib, Abusurj, Dign Elbasha, Seisaban, Sidr, Peltophorum) delayed emergence by 50% in sorghum. In all residue extracts, sorghum seeds had significantly (P≤0.04) higher germination (78.8%) and survival of seedlings (76.9%) than maize (62.5% & 68.8%, respectively). Hypocotyl length of maize (2.9 cm) across all residue extracts was statistically similar to that of sorghum (2.7 cm). However, radicle length of maize (2.7 cm) was significantly (P≤0.005) more than

Table I. Effects of leaf extracts of some tree species on maize and sorghum seed germination (%), seedling survival (%), hypocotyl and radicle length (cm) and days to first emergence

	Germination (%)		Survival (%)		Hypocotyl length (cm)		Radicle length (cm)		Days to emergence	
Tree species	**Maize**	**Sorghum**	**Maize**	**Sorghum**	**Maize**	**Sorghum**	**Maize**	**Sorghum**	**Maize**	**Sorghum**
Ardeib.	75.0 b	75.0 c	50.0 d	33.0 g	2.5 c	3.3 a	0.7 f	0.2 e	2.0 b	2.0 a
Mahogany	75.0 b	98.7 a	50.0 d	99.0 a	1.6 e	2.9 b	1.5 e	1.7 b	2.0 b	1.2 b
Ban	87.5 a	74.7 c	71.0 c	99.0 a	1.9 d	2.5 cd	3.4 d	3.3 a	2.0 b	1.0 b
Abu Surj	62.5 c	87.5 b	99.0 a	57.0 f	2.0 d	2.7 bc	3.8 c	1.0 cd	2.0 b	2.0 a
Dign Elbasha	50.0 b	99.0 a	75.0 b	87.5 b	4.0 a	2.8 bc	1.6 e	0.8 d	2.0 b	2.0 a
Sunut	50.0 d	87.5 b	50.0 d	71.4 d	3.3 b	3.3 a	4.7 b	1.6 b	2.0 b	2.0 a
Seisaban	25.0 e	62.5 d	50.0 d	80.0 c	4.0 a	2.3 de	6.0 a	1.2 c	2.0 b	2.0 a
Sidr	50.0 d	50.0 e	75.0 b	99.0 a	4.2 a	2.4 d	1.6 e	0.2 e	2.0 b	2.0 a
Peltophorum	87.5 a	74.5 c	99.0 a	67.0 e	2.5 c	2.0 e	0.7 f	0.2 e	2.0 b	2.0 a
Distilled water	87.5 a	100.0 a	99.0 a	87.5 b	3.5 b	2.0 e	3.2 d	1.0 cd	3.0 a	1.0 b
C.V. (%)	3.2	2.6	2.5	1.1	0.1	6.5	6.2	14.4	9.7	14.1
P value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001

Means in a column followed by the same letter (s) are not significantly different at P≤0.05, by Duncan Multiple Range Test

double that of sorghum (1.12 cm).

The results of this study indicated that extracts from fresh leaves of nine tree types contained substances with varying degrees of inhibitory effect on seed germination and survival of seedlings of maize and sorghum. This result showed that *E. camadulensis* extracts reduced germination of sorghum but not maize. Allelopathic effect of extracts from *Eucalyptus* spp. were reported earlier by Sanker and Rai (1993) and El Atta and Bashir (1999). The allelopathic effects have been attributed to phenolic compounds, principally the cinnamic acid derivatives ferulic acid, *p*-coumaric acid, chlorogenic acid and isochlorogenic acid (Hall *et al*., 1982). The differences in the tolerance levels between maize and sorghum could possibly be due to the selective permeability of the seed coat to the inhibitory substances (Zakaria & Razak, 1990). Allelochemicals might be inactivated in the soil by different factors such as chelation with ions, complexation with soil colloids (both organic & inorganic), decomposition by micro-organisms or mechanical forces. On the other hand, they might accumulate to toxic levels when environmental conditions favored the retention of allelochemicals in the soil (Purvis, 1990). Therefore, further investigation is needed to study the effects of soil factors (e.g., soil texture, moisture content, pH, mineral & humic acid content) when crops are sown after mulching with prunings from agroforestry trees.

It could be concluded that most extracts from fresh tree litter are phytotoxic to germination of the subsequent maize and sorghum crops.

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